8.7 NOISE

This section presents an assessment of potential noise and vibration effects related to the Pico Power Project (PPP). This assessment includes an evaluation of the potential effects to the nearest sensitive receptors and to plant operations personnel. Conformance of the project to the City of Santa Clara's noise ordinance and noise and land use compatibility guidelines for the Industrial Zone was also assessed. Section 8.7.1 discusses the affected environment, including baseline noise level survey methodology and results. Section 8.7.2 discusses the environmental consequences from construction and operation of the power plant and associated facilities. Section 8.7.3 discusses cumulative impacts. Section 8.7.4 discusses mitigation measures. Section 8.7.5 presents applicable laws, ordinances, regulations, and standards. Section 8.7.6 presents agency contacts, and Section 8.7.7 presents permit requirements and schedules. Section 8.7.8 contains references.

8.7.1 Affected Environment

The proposed PPP site is located within an industrial area approximately 0.6 miles northwest of the end of the runway of San Jose International Airport and 0.1 miles south of the Bayshore Freeway (US Highway 101). Coincidentally, the 70 dBA CNEL contours of the airport and the freeway pass through the site (City of Santa Clara 1992). The Owens Corning fiberglass insulation manufacturing plant located approximately 0.25 miles to the south and the LSI Logic manufacturing facility located approximately 0.35 miles to the west are also significant sources of noise.

The nearest established residential area begins 0.51 miles north of the site on the northeast side of Lafayette Street and extends to the north. The entire residential subdivision lies within the 65 to 75 dBA CNEL contours of the airport. A much smaller area that could be considered residential is a motel consisting of approximately ten units that have been converted to very small apartments. This facility is immediately adjacent to the north side of the Bayshore Freeway in the 75 dBA CNEL contour approximately 0.35 miles northeast of the Pico site. The nearest school is the Granada Islamic School located approximately 0.42 miles west of the site in a commercial area. Other uses in the area are commercial, consisting of office/warehouses and small manufacturing facilities.

The CEC's power plant certification regulations require that noise measurements be made at noise-sensitive locations where there is a potential for an increase of 5 dBA or more over existing background noise levels during construction or operation of a proposed power plant. Although it was not anticipated that plant noise would increase the ambient levels at the nearest residences or the school by 5 dBA, an ambient noise survey was conducted adjacent to these areas, since there are no other noise-sensitive uses nearer to the site. Ambient noise level measurements were also made at one location on the power plant site boundary.

The survey was conducted at the four locations on June 11 and 12, 2002. The monitoring locations and receptor locations are shown in Figure 8.7-1. A brief description of each monitoring location and the types of sounds heard during the survey are presented below. Photographs of each location are presented in Figure 8.7-2.

Location 1—This site was located adjacent to the north residential area at 3501 Lafayette Street. The microphone was mounted on a post supporting a newly planted tree (Figure 8.7-2) across the fence to the south from the residences and approximately 150 feet from the traffic on Lafayette Street. The primary sources of noise in this location are jet aircraft arriving and departing from the San Jose International Airport, traffic on Lafayette Street, and HVAC equipment on area commercial buildings.

Location 2—This monitoring site is on the northeast corner of the power plant site, which is not a noise-sensitive location. These levels are simply presented for reference. The microphone was mounted on the guywire of a power pole on the site (Figure 8.7-2). The sources of noise heard were the same as those at Location 1, plus the Owens Corning plant to the south.

Location 3—This site is adjacent to the north side of the Granada Islamic School 0.42 miles west of the site. The microphone was attached to the branch of a small tree just north of the fence at the north end of the school. The school is located with the 65 dBA CNEL contours of both the airport and the Bayshore Freeway. Other sources of noise, in addition to jet aircraft and freeway traffic, were heating and air conditioning (HVAC) equipment on nearby commercial buildings and local traffic.

Location 4—This monitoring site is at the apartments located at 1425 Laurelwood Road approximately 0.39 miles northwest of the site and on the north side of Bayshore Freeway. Laurelwood Road is a frontage road to the Bayshore Freeway. The single line of apartments is oriented perpendicular to the freeway. The microphone was mounted on the post of a chainlink fence in front of the apartment unit most distant from the freeway (approximately 350 feet). Freeway traffic and jet aircraft were the primary sources of noise. Mechanical equipment to the south could be heard late at night.

8.7.1.1 Noise Survey Methodology

Continuous measurements of the A-weighted sound levels were made simultaneously over a complete 25-hour period using four (4) Larson-Davis Laboratories Model 820 sound level meters (LDL 820) with integral data loggers. The instruments meet the requirements of ANSI S1.4-1983 for Type I precision sound level meters. The Larson-Davis Model 2561 half-inch prepolarized random incidence microphones were remotely mounted (via a 10-foot microphone extension cable and preamplifier) at a height of approximately 5 feet above the ground. Foam windscreens, 3½ inches in diameter, were used to reduce wind-generated noise.

The calibration levels of the instruments were checked before and after the 25-hour monitoring period using a B&K Type 4230 sound level calibrator. The analyzers were internally timed to turn on and off automatically at the same time on the start and stop days, respectively. They were generally unattended during the monitoring period, but the monitoring technician did visit each site four times to make observations approximately sounds heard and general weather conditions. Observations were made during the first hour between 1500 and 1600, in the evening between 2000 and 2100, late at night between 0230 and 0330, and mid-morning between 1000 and 1100.

The LDL 820s were programmed to measure and record the equivalent sound level (L_{eq}) for each minute of the 25-hour period as well as compute and store the statistical sound levels exceeded 10, 50, and 90 percent of each hour (L_{10}, L_{50} and L_{90}). The L_{eq} for each hour of the period was also computed and recorded. At the end of the 25-hour period, the data was downloaded directly into a laptop computer for storage and further analysis, including computation of the 24-hour L_{eq}, day/night level (L_{dn}), and the community noise equivalent level (CNEL). A spreadsheet program was used to generate graphs of the data. One graph was produced of the 1-minute L_{eq} levels to show the often rapid variation in sound levels experienced in outdoor environments. Another graph was produced of the hourly L_{eq} levels and the L_{50} and L_{90} statistical sound levels, showing all three curves in the same plot.

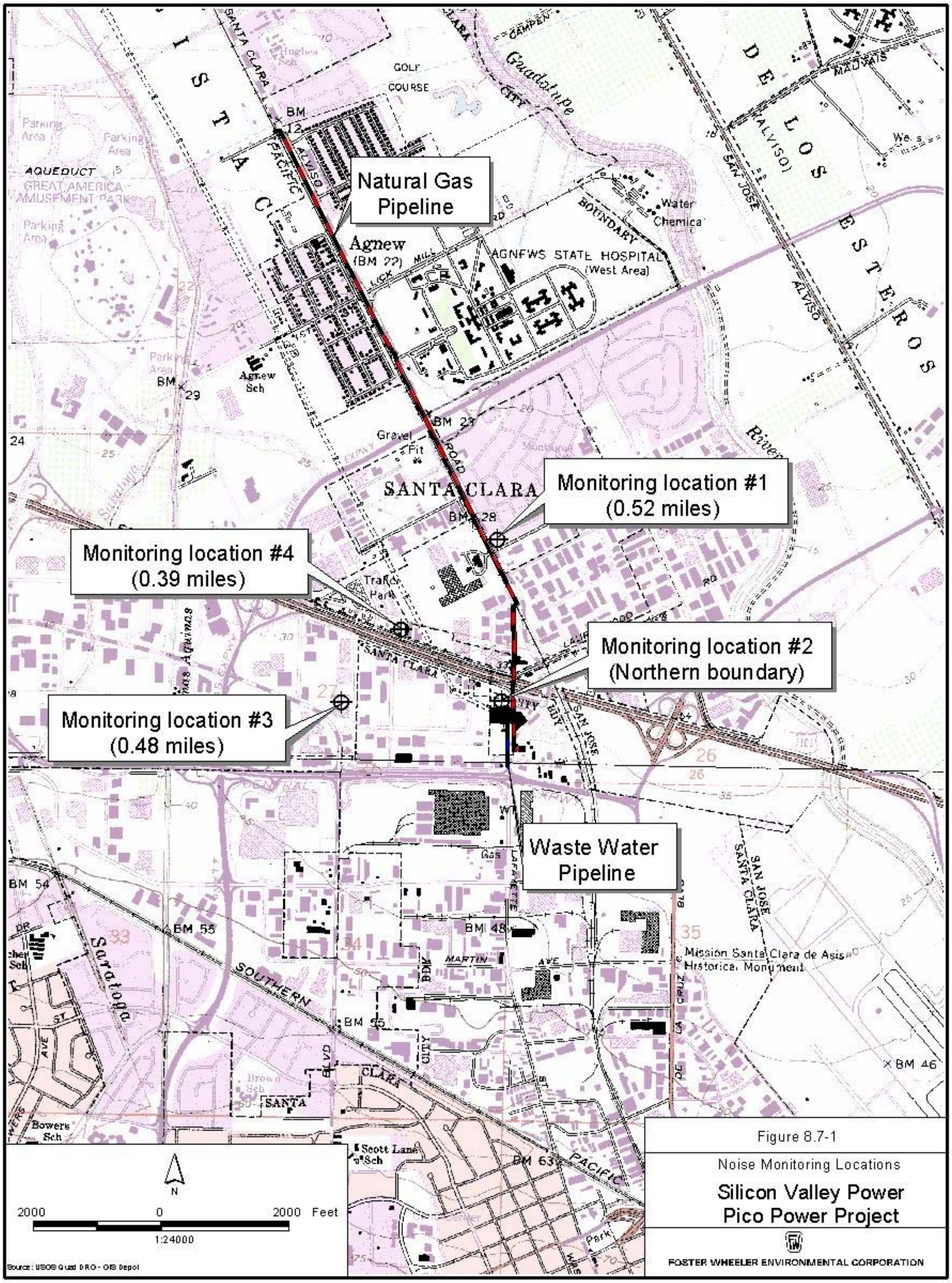
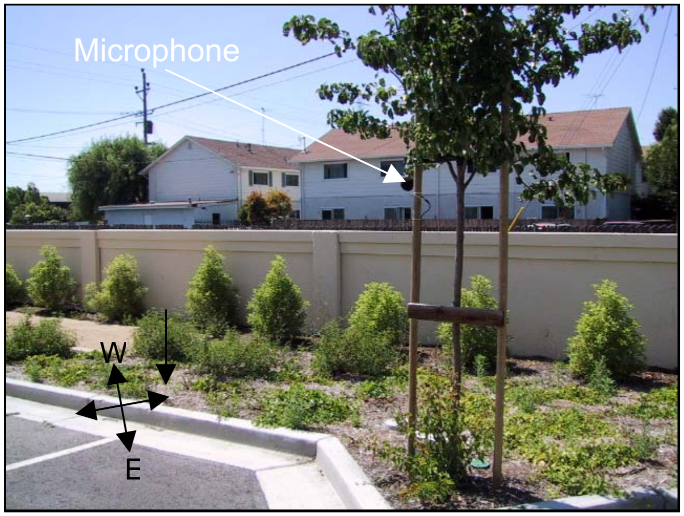


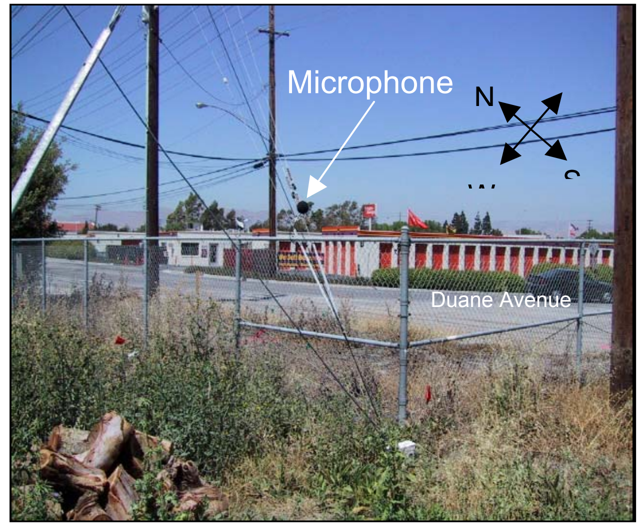
Figure 8.7-1

Noise Monitoring Locations

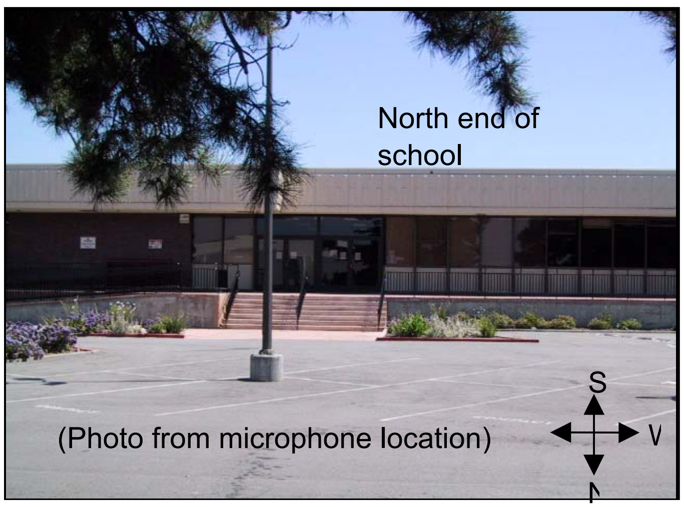
Silicon Valley Power Pico Power Project



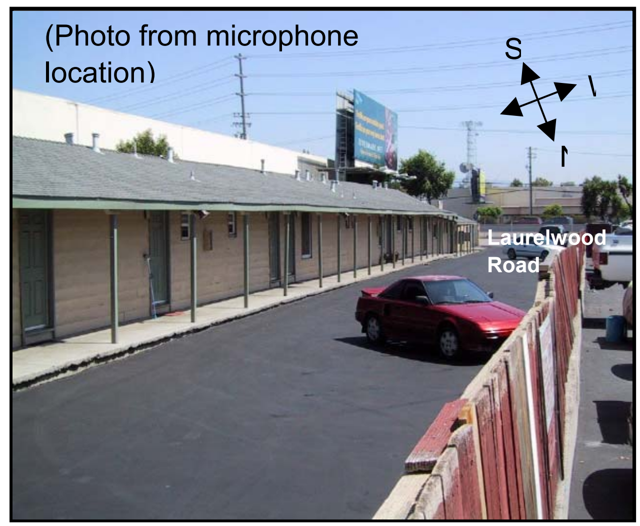
Location 1: Nearest residences to North



Location 2: NE Corner of Site



Location 3: Granada Islamic School



Location 4: Apartments NW of Site

Figure 8.7-2. Photos of Noise Monitoring

One-third octave band data were obtained using a Larson-Davis Laboratories Model 2800 Audio Spectrum Analyzer. These data were obtained during the late-night period when ambient noise was at a minimum and again during mid-morning. Levels were integrated over 30-second measurement periods when intrusive noises were at a minimum to the extent practicable.

8.7.1.2 Noise Survey Results

Weather conditions during the survey were mild, with temperatures ranging from 59 degrees at night to 78 degrees during the day. Relative humidity levels ranged from 49 percent during the the day to 81 percent during the night. Winds were light, ranging from calm to approximately 9 mph, and the direction was generally from the north to northwest and the skies were clear.

The hourly L_{eq} levels along with the three commonly used 24-hour composite noise descriptors of the continuous A-weighted sound levels are presented in Table 8.7-1 for the four monitoring locations. The average nighttime L_{90} for the locations is also presented on the bottom row of the table. This descriptor has no regulatory basis but is useful for comparison with continuous sources of industrial noise such as power plants, and for assessing noise impacts.

The City of Santa Clara Planning Department's Noise and Land Use Compatibility Chart (City of Santa Clara, 1992) indicates that CNEL or L_{dn} levels of up to 55 dBA are compatible with outdoor residential spaces and public educational facilities. Houses and schools located in higher levels up to 70 dBA CNEL require design and insulation to reduce interior noise levels. Levels above 70 dBA CNEL are considered incompatible for such land uses. The City of Santa Clara recognizes, via the noise contours presented in the General Plan, that all of the areas measured in this study are already above the 55 dBA level identified as compatible. The CNEL levels measured during this study (Table 8.7-1) are consistent with or slightly below the noise contours presented in the General Plan. The measured levels ranged from a low of 65.3 dBA at the Granada Islamic School to a high of 71.5 dBA at the residences to the north. The corresponding CNEL contours for these two locations are 65 and 75 dBA, respectively.

The usefulness of this energy-averaged data is somewhat limited in describing the noise environment, however, because of the disproportionate influence that a few high sound level intervals can have on the 24-hour averages. This is due to the logarithmic nature of the averaging process whereby, for example, a level of 60 dBA contains ten times the energy of a 50 dBA level and counts ten times as much in the average. Using the statistical L_{50} and L_{90} levels (sound levels exceeded 50 percent or 90 percent of the time, respectively, at a given location) overcomes these problems by eliminating these short-duration intrusive events from the record. Graphs of the continuous data using these statistical measures present a much more detailed description of the noise environment against which noise from the proposed project should be considered.

Graphs showing noise levels at the four monitoring stations are presented in Figures 8.7-3 through 8.7-6. The first graph in each figure is a plot of the 1-minute L_{eq} levels. The effects of individual noise events, such as the passage of heavy trucks, trains, and jet aircraft can be seen as tall spikes in these graphs. The second graph for each location shows the hourly equivalent noise levels and the statistical levels exceeding 50 and 90 percent of each hour (L_{eq}, L_{50} and L_{90}). Of the three lines on these graphs, the L_{90} background or residual sound levels are the most important for impact assessment purposes. The L_{90} level would be most affected by a new facility such as a power plant that generally produces a constant level of noise, effectively raising the background noise level (L_{90}) near the plant. The most

Table 8.7-1. Summary of hourly sound levels.

		Location 1 3501 Lafayette Street				Location 2 North Site Boundary				Location 3 Granada Islamic School				Location 4 1425 Laurelwood Road			
Date	**Hour**	**Leq**	**L10**	**L50**	**L90**	**Leq**	**L10**	**L50**	**L90**	**Leq**	**L10**	**L50**	**L90**	**Leq**	**L10**	**L50**	**L90**
6/11/02	1500	65.5	65.3	59.2	56.5	63.7	64.5	59.9	58.1	62.6	63.9	61.0	59.2	63.2	63.6	59.6	57.9
"	1600	70.0	69.0	59.7	56.4	66.5	65.8	59.7	57.5	63.9	64.7	59.8	58.7	65.2	63.6	58.2	56.4
"	1700	68.5	69.2	58.5	54.9	65.7	68.4	58.7	56.8	63.3	66.4	59.7	58.4	65.1	67.7	58.1	56.2
"	1800	68.9	66.3	57.1	53.7	66.0	65.4	59.8	57.8	63.9	64.5	60.0	58.1	65.3	64.6	59.4	57.1
"	1900	70.7	69.7	57.2	53.3	68.6	69.5	60.3	58.4	65.7	68.3	60.5	58.3	68.3	69.7	61.8	59.7
"	2000	72.3	65.0	55.6	52.5	65.6	63.5	59.5	57.7	62.9	62.7	59.3	57.1	66.1	65.9	61.0	59.2
"	2100	66.3	62.1	54.0	50.9	63.4	60.5	57.8	56.2	61.4	61.4	57.5	55.4	64.6	63.8	60.0	57.8
"	2200	61.0	57.1	50.8	47.5	60.2	59.0	56.4	54.5	58.2	57.7	55.1	53.1	62.1	61.5	57.5	55.0
"	2300	60.3	54.6	48.0	46.3	58.6	57.5	55.1	53.5	56.0	55.9	52.9	51.3	60.3	61.3	56.4	53.7
6/12/02	0000	51.3	51.5	46.3	45.2	54.6	56.0	54.0	52.4	53.3	55.0	52.5	51.1	54.9	57.3	54.1	51.1
"	0100	48.6	49.4	46.3	45.2	54.9	56.2	54.0	52.4	58.1	55.4	52.2	51.1	53.5	56.0	52.3	48.8
"	0200	46.2	47.2	44.8	43.3	54.2	55.8	53.4	51.9	53.1	54.9	52.4	51.1	52.5	55.5	50.9	46.9
"	0300	50.0	50.9	46.7	43.9	56.3	58.0	56.1	53.3	55.9	56.8	54.5	51.7	56.1	59.7	53.5	47.9
"	0400	53.9	57.9	49.3	46.6	57.2	58.7	56.9	55.4	54.4	56.1	53.9	52.7	58.2	61.4	56.9	51.8
"	0500	55.6	58.2	52.7	50.4	59.2	60.7	58.8	57.2	56.0	57.4	55.2	53.7	61.6	63.7	61.1	57.6
"	0600	70.1	62.8	55.3	51.9	62.5	63.8	60.8	59.0	57.7	59.8	56.6	55.2	64.0	65.7	63.6	61.7
"	0700	69.6	66.5	57.6	53.1	63.1	64.6	60.8	59.0	58.0	59.4	56.9	55.3	64.4	66.0	63.9	62.1
"	0800	70.2	65.5	57.3	52.5	61.6	63.5	59.7	57.8	57.2	58.8	56.4	54.1	62.8	64.8	62.3	60.4
"	0900	68.9	66.8	56.6	51.8	62.5	64.9	60.6	57.3	58.0	59.5	56.6	53.5	61.8	63.5	61.3	59.2
"	1000	69.0	63.4	55.3	51.0	63.9	65.9	62.4	60.0	57.9	58.8	56.2	54.7	62.7	64.2	61.5	59.3
"	1100	70.0	66.4	57.2	53.0	68.0	66.4	59.6	57.6	64.0	65.2	58.9	55.6	66.2	65.5	59.5	57.0
"	1200	71.6	70.6	58.7	54.3	69.1	69.6	58.9	56.6	65.9	68.2	60.5	58.6	67.9	69.1	59.1	56.6
"	1300	68.0	67.7	58.4	55.2	66.6	66.1	60.9	58.0	63.3	65.2	59.8	58.3	66.9	71.1	60.6	57.5
"	1400	68.2	69.3	58.9	55.6	64.6	66.3	61.4	57.9	63.6	65.3	61.0	58.9	65.6	69.3	61.5	57.5
"	1500	66.9	67.7	58.3	54.9	63.9	64.0	59.1	57.2	62.6	63.8	60.4	59.0	63.0	63.0	58.0	56.1
	Leq(24)	67.9				64.2				61.4				64.1			
	DNL	70.5				67.0				64.5				67.6			
	CNEL	71.5				67.9				65.3				68.4			
Arith Avg. first 24-			62.2	54.2	51.0		62.9	58.6	56.5		60.9	57.1	55.2		63.9	58.9	56.2
Log Avg. first 24-			65.6	56.1	52.5		64.7	59.2	57.0		62.9	57.9	56.1		65.6	60.0	57.6
Arith Avg. night			54.4	48.9	46.7		58.4	56.2	54.4		56.6	53.9	52.3		60.2	56.3	52.7
Log Avg. night			56.9	50.3	47.6		59.2	56.8	55.1		56.8	54.2	52.6		61.4	58.1	55.3

Note 1: Nightime hours are shaded.
Note 2: Hour indicates hour beginning

important time period for noise impact assessment purposes is late at night during normal sleep hours, when ambient noise levels are low because human activity is at a minimum, and wind speeds have generally diminished. The CEC considers an increase in the late night L_{90} levels of greater than 5 dBA, resulting from a power plant, to be a significant impact.

The L_{90} pattern at the residential area on Lafayette Street (Location 1, Figure 8.7-3, lower curve of the lower graph) is typical of most urban areas subject to traffic and other manmade noises. The level is higher during the day, but it drops off as the level of activity diminishes, reaching a minimum between approximately 2 and 4 a.m. At this location, the minimum L_{90} level was approximately 43 dBA with an overall nighttime average L90 of 47.6 dBA (Table 8.7-1). The Leq level, from which the CNEL measure is derived, is almost entirely driven by the intrusive noise events created by jet aircraft from the San Jose International Airport and heavy truck traffic. The CNEL was 71.5 dBA, which is well above the 55 dBA level considered to be compatible with residential land uses.

The graphs for Location 2 at the project site's northern boundary (Figure 8.7-4) present a similar diurnal pattern of lower levels at night related to man-made noise. Nighttime levels reached a minimum of approximately 52 dBA between 2 and 3 a.m. It is likely that noise from the Owens Corning fiberglass insulation manufacturing plant to the south is the main contributor to this 52 dBA L90 level at night. Daytime levels were typically above approximately 58 dBA. The CNEL was 67.9 dBA which is very close to the 70 dBA CNEL contour presented in the General Plan.

Noise levels at Location 3, on the north side of the Granada Islamic School (Figure 8.7-5), produced the same diurnal pattern as at Location 2. A relatively constant L90 level of 51 dBA was maintained at night by HVAC equipment on nearby commercial buildings. In fact, when certain units turned on, the noise level increased from 51 dBA to approximately 55 dBA; dropping when the unit turned off. The CNEL was 65.3 dBA, which is almost exactly the same as the 65 dBA aircraft and freeway traffic noise contours that cross over the school.

At Location 4 (apartment building on Laurelwood Road), the measured CNEL level at the apartments on Laurelwood Road was 68.4 dBA which is somewhat below the 75 dBA level indicated by the Bayshore Freeway noise contours in the City General Plan. This is likely because of shielding provided by large buildings on both sides of the apartments that block freeway noise except from traffic that is directly in front of the apartments. The contours presented in the General Plan do not take local shielding factors into consideration. The building on the east side of the apartments will also block noise from the power plant to the apartments. The minimum measured hourly L90 level shown in Figure 8.7-6 for the location is 47 dBA between 2 and 3 a.m. The average nighttime L90 is 55.3 dBA (Table 8.7-1).

The 1/3 octave band data are presented in Figure 8.7-7 for all four monitoring locations. These data were obtained during the late-night period when ambient noise was at a minimum and again during mid-morning. Levels were integrated over 30-second measurement periods when intrusive noises were at a minimum to the extent practicable. As expected, the nighttime levels are lower than the daytime levels. The tall peak on the right side of each chart is the C-weighted sound level followed by the A-weighted level computed from the 1/3 octave band data. The smaller peaks seen around 50 Hz in three of the charts are indicative of industrial noise sources. The two high frequency peaks seen near 5000 Hz are due to insect noise near the microphones.

In summary, jet aircraft and freeway traffic noise dominate the area around the power plant site. The nearest established residential area is heavily impacted by the jet aircraft noise in particular. The existing noise levels are compatible with industrial development but not with residential or other noise-sensitive developments.

8.7.1.3 Vibration

The PPP will be a combined-cycle facility that produces electricity by rotating combustion turbines and a steam turbine which uses steam produced from the combustion turbine waste heat in the heat recovery steam generators (HRSGs). The HRSGs act as turbine exhaust noise silencers. The equipment that will be used in the PPP facility will be well-balanced and is designed to produce very low vibration levels that will be maintained throughout the life of the plant. Any imbalance could contribute to ground vibration levels in the vicinity of the equipment. However, vibration monitoring systems installed in the equipment are designed to ensure that the equipment remains balanced. Should an imbalance occur, the event will be detected and the equipment will automatically be shut down for repair and re-balancing. Vibration can be transmitted through the ground and through the air, but the analysis techniques for each path are different.

Ground Vibration

Energy generated by vibrating and/or rotating equipment and construction activities is transmitted through surrounding soils in three principle wave forms: compression (P-waves), shear (S-waves), and surface waves. P- and S-waves are referred to as body waves. The primary type of surface wave is the Rayleigh wave. Of the three types of waves, approximately 70 percent of the energy is transmitted as a Rayleigh wave and therefore the wave propagation characteristics of the Rayleigh wave largely govern the vibration effects.

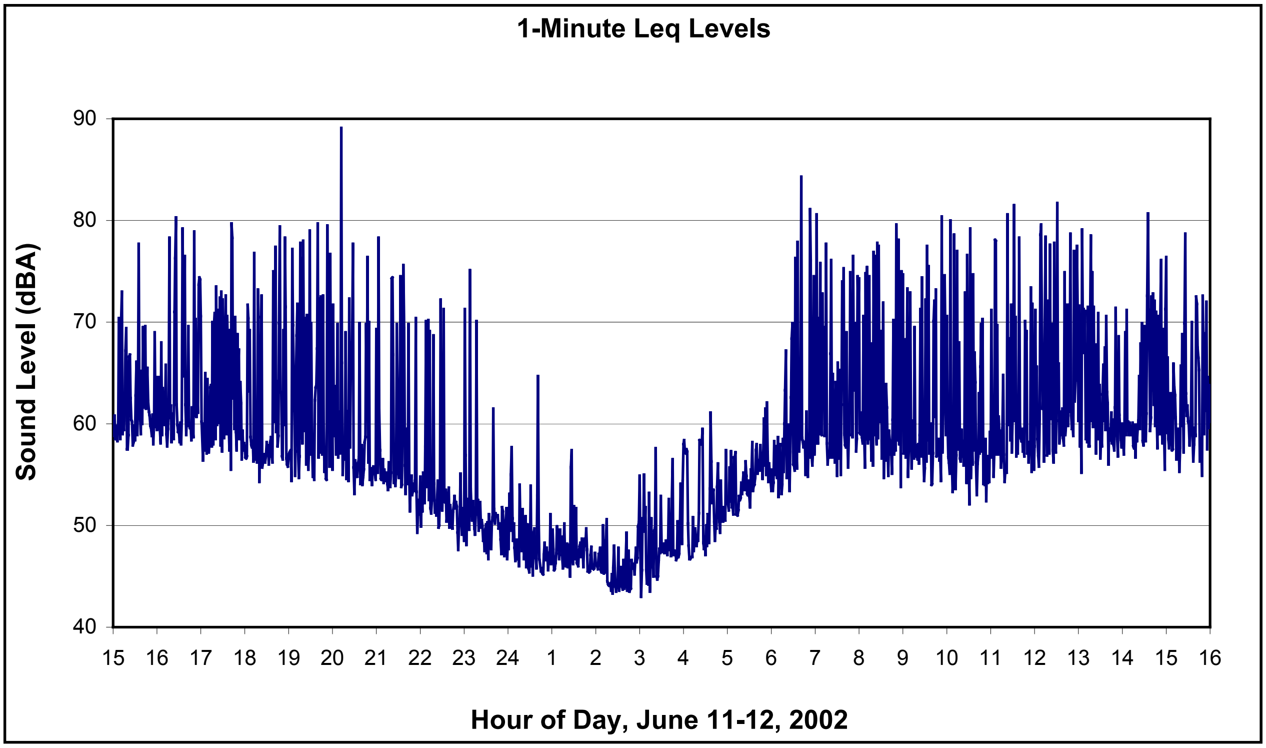
The Rayleigh wave propagates radially outward from the source of the vibration. All waves lose energy as they travel outward and pass through an increasingly larger volume of material. This energy loss is called geometrical damping. The decrease in energy (attenuation) for Raleigh waves is inversely proportional to the square root of the distance from the source. Because soils are not perfectly elastic, internal friction also reduces the energy of the wave vibration, increasing the attenuation predicted by just geometrical damping alone. This factor is called the material damping coefficient and its value is somewhat dependent on the soil types. For practical applications, considerations of geometrical and material damping, as well as the type of wave and the wave's energy attenuation characteristics, have been combined into a single expression:

$$A = A_o \ (r_o/r)^{\gamma}$$

where:

where:	A	=	Wave amplitude at distance "r"
	A_o	=	Wave amplitude at source, "r_o"
	r	=	Distance
	γ	=	Dimensionless damping coefficient with an approximate value of 1.5 for soft soil sites and 1.0 for firm soil sites

As a simple example, the vibration from a source on a site with firm soils is approximately 100 times less at a distance from the source of 100 feet and 1,000 times less at a distance of 1,000 feet. Attenuation is greater for sites built on soft soil than for sites built on firm soils.



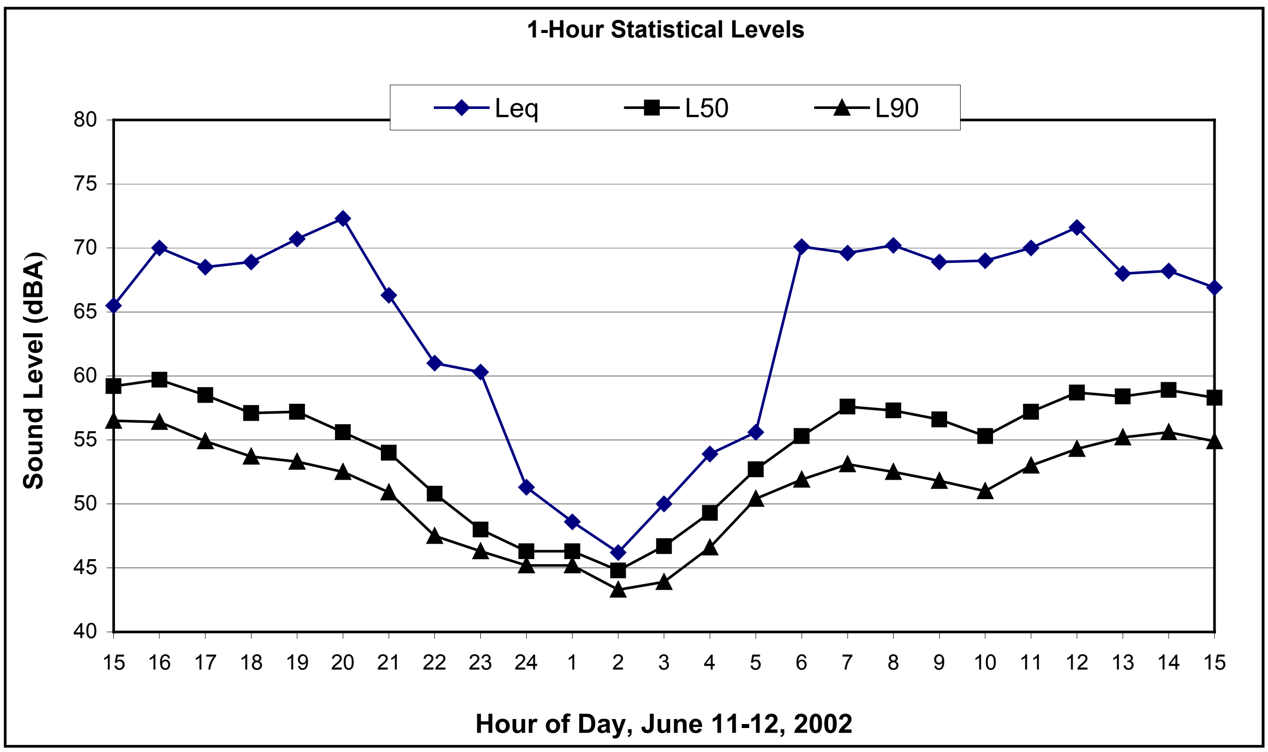
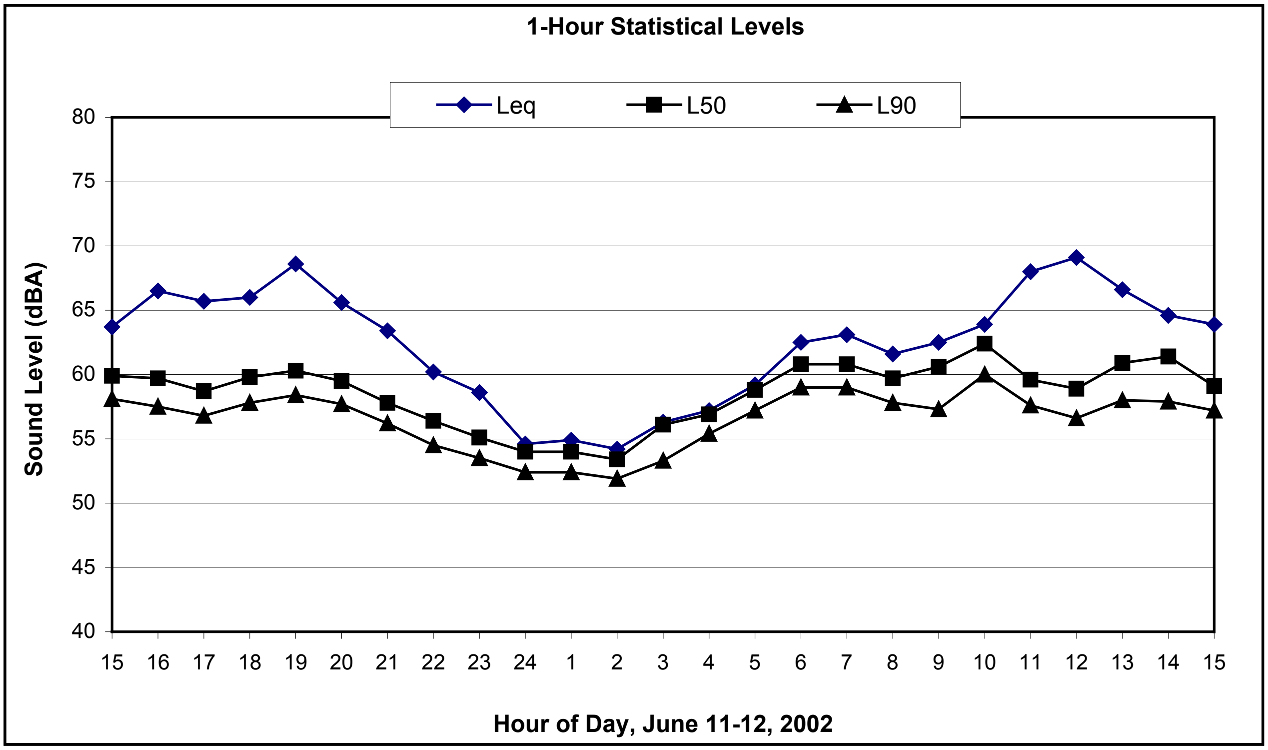


Figure 8.7-3. Location 1: Nearest residence at 3501 Lafayette Street.



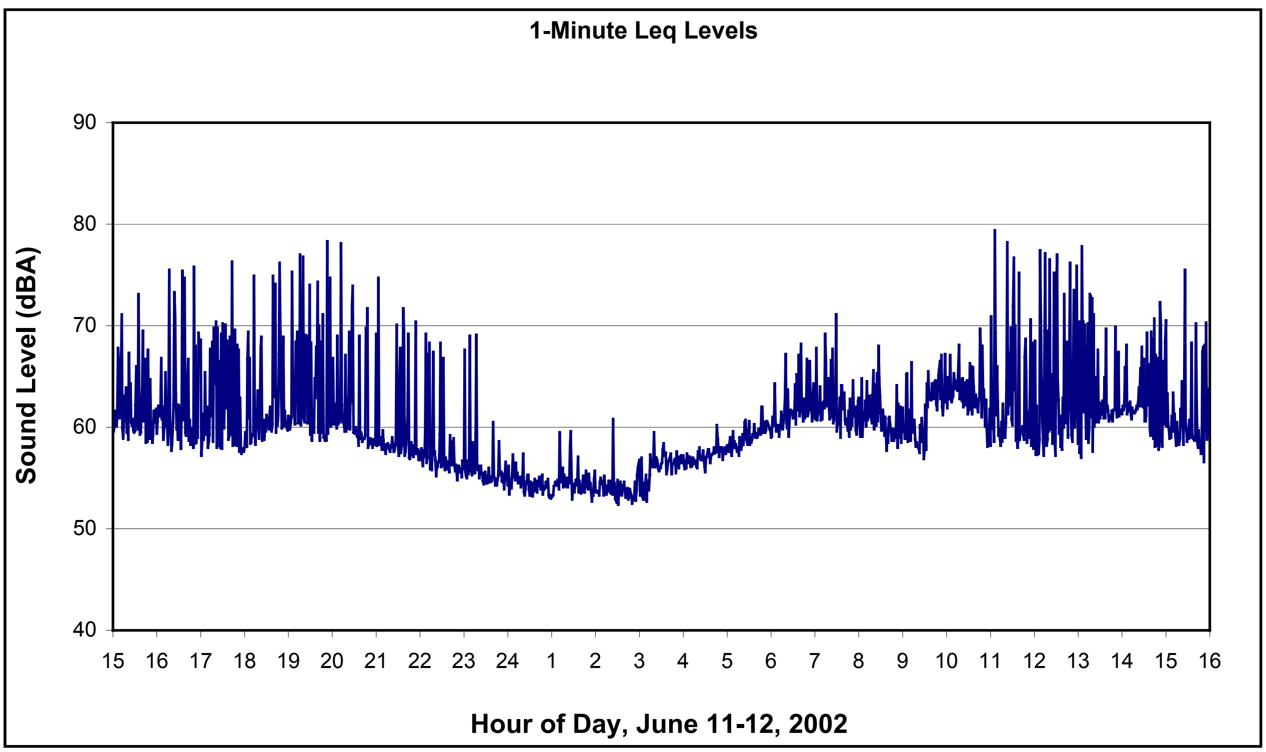
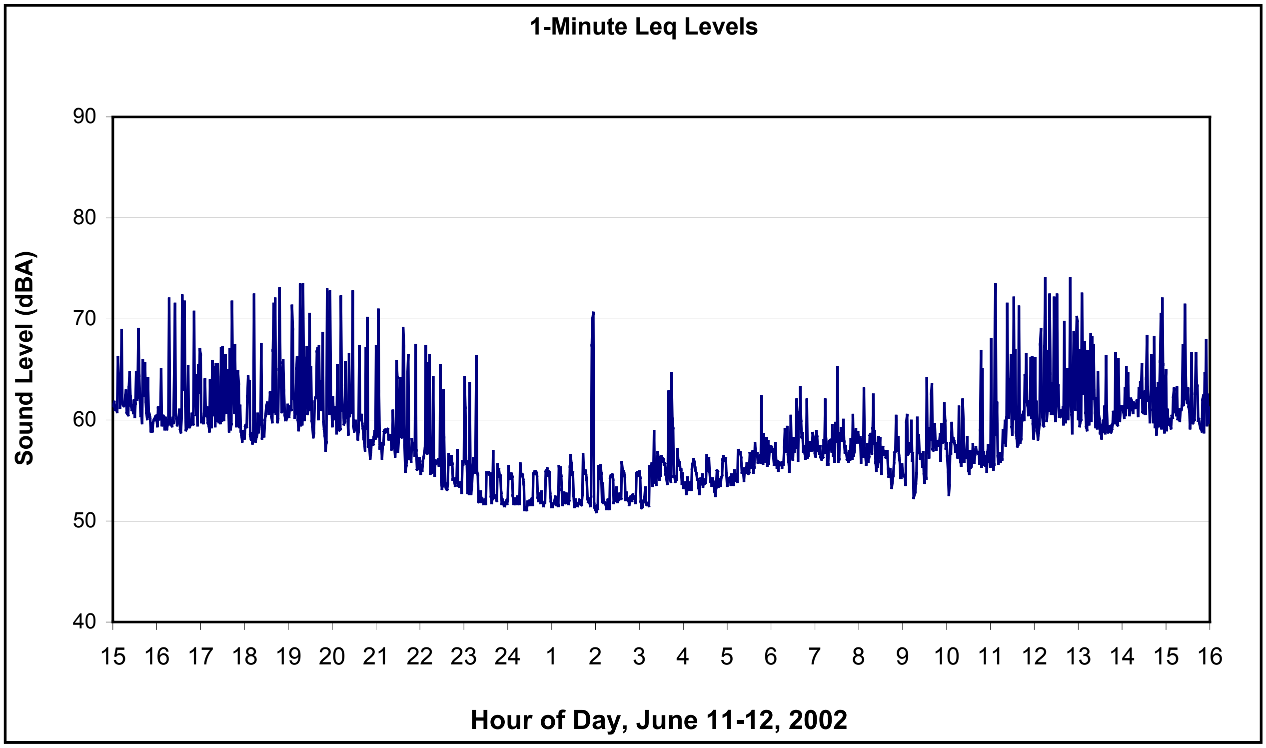


Figure 8.7-4. Location 2: North boundary of the project site.



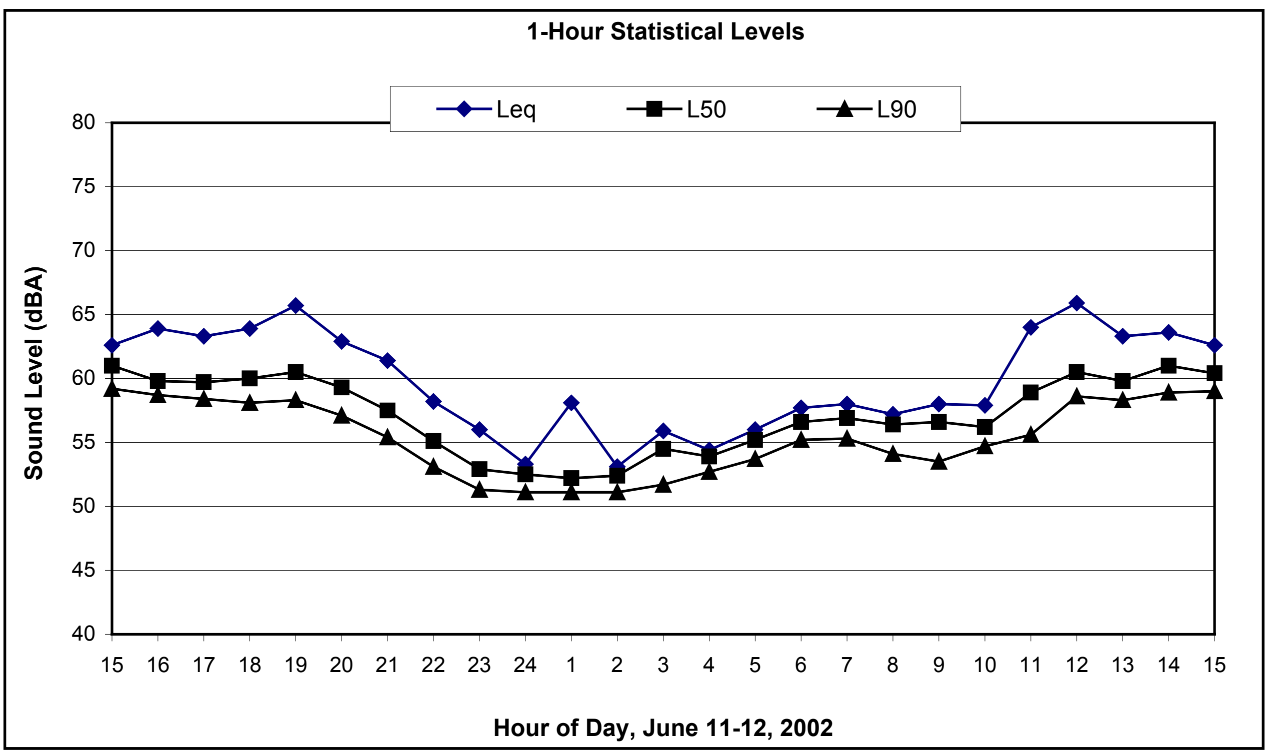
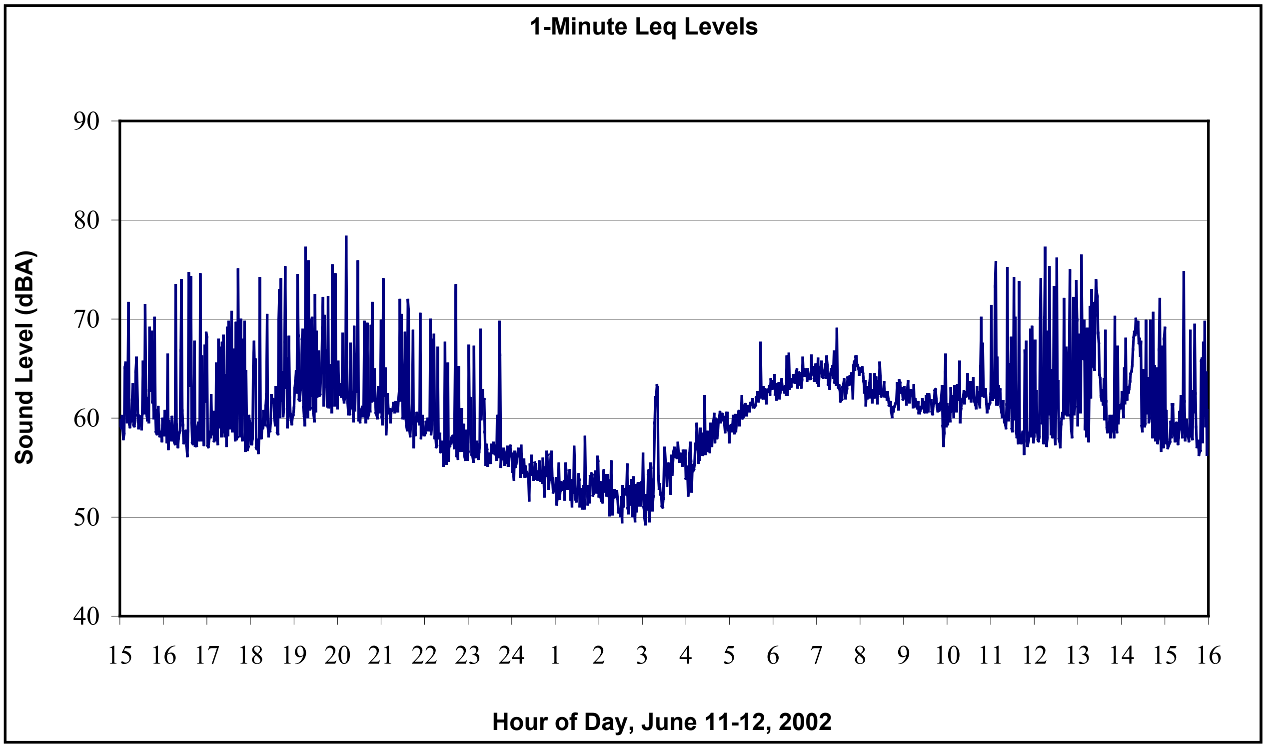


Figure 8.7-5. Location 3: Granada Islamic School.



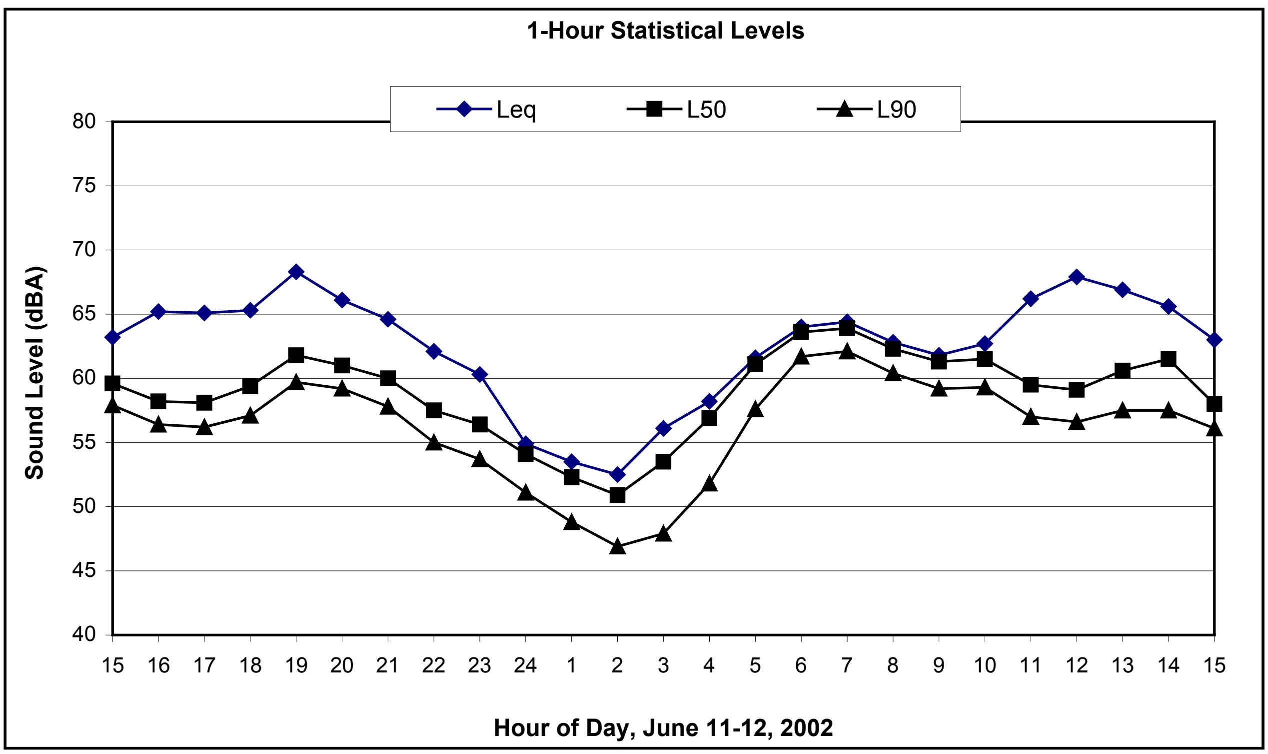


Figure 8.7-6. Location 4: Apartments at 1425 Laurelwood Road.

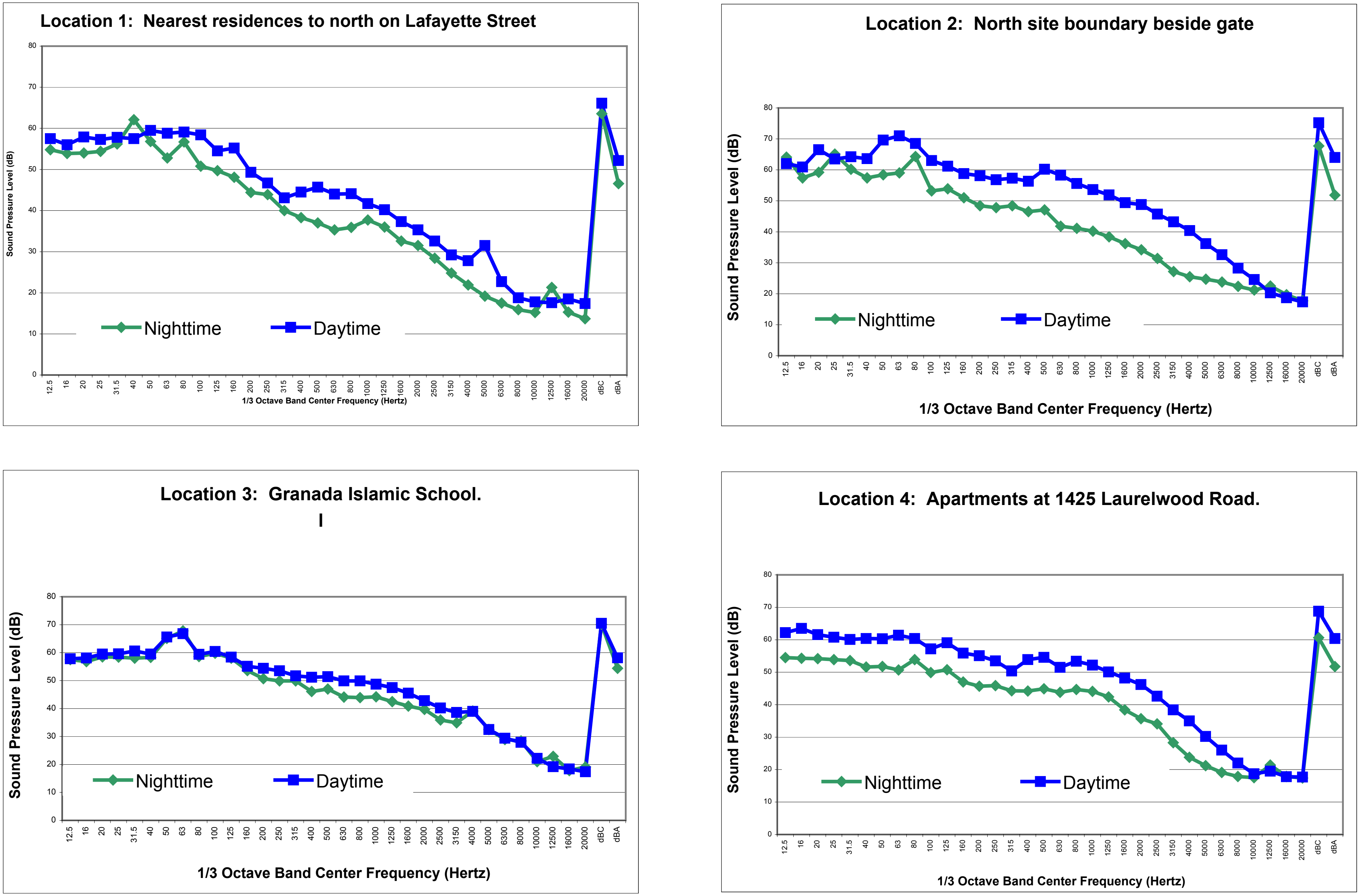


Figure 8.7-7. Existing 1/3 octave band levels plus C- and A-weighted levels.

Several key principles need to be satisfied to assure that machine foundations meet the operating requirements of the plant. For static loading, the foundations must be safe against bearing capacity failure and excessive settlement. For dynamic loading, the foundation should not resonate, the amplitudes of motion should not exceed permissible values, the natural frequency of the foundation-soil system should not be a multiple of the operating frequency of the machine, and the vibrations caused by the machine should not affect equipment or machinery in the facility or neighboring facilities.

In general, the permissible amplitudes of motion control the machine foundation design and affect the vibration levels at the surrounding structures. For modern power plants, the permissible levels of motion, expressed in terms of peak particle velocity, are set in the range of 0.10 to 0.20 inches per second. For the major components of the plant, such as the combustion turbines, the permissible vibration levels are set even lower, at a maximum of 0.06 inches per second.

If the equipment were allowed to operate at the maximum of 0.20 inches per second, the expected vibration level at the nearest point on the site boundary would be approximately 0.004 inches per second. This level is, coincidentally, at the threshold of perceptible vibration (Beranek 1988). Thus, vibration levels would be imperceptible beyond the site boundary. For comparison, the vibration generated by a moving truck on a typical city street at a distance of 10 feet is approximately 0.60 inches per second peak particle velocity (approximately 150 times the vibration level anticipated at the closest point to major equipment on the Pico site boundaries).

International organizations have also set standards for permissible vibration levels. The Swiss have set the most restrictive standards and the most restrictive level of induced vibration is called "Swiss IV." This criteria limits the vibration induced in buildings that are "very sensitive to vibrations" to a level of 0.12 to 0.20 inches per second. The vibration levels anticipated at the PPP are significantly below even this most restrictive threshold level.

Airborne Vibration

Low-frequency noise in the air can induce vibrations in lightweight building structures that could be perceived as windows or objects on shelves rattling. The vibration of windows or walls could also be perceived through touch. Gas turbines in simple-cycle operation commonly produce airborne low frequency noise emissions that are capable of inducing perceptible vibration in nearby structures with lightweight frame construction. However, gas turbines in combined-cycle installations, such as the Pico project, rarely, if ever, cause this type of problem. The expansion of the combustion turbine exhaust gases inside the large cavity of the HRSG (which has dimensions that are comparable to the wavelength of sound in the typically problematic 20 to 30 Hz region of the spectrum) and the subsequent contraction in the exhaust stack act to dissipate acoustic energy. The ability of HRSGs to attenuate turbine exhaust noise, even when no specific silencing measures are incorporated into the design, is a well-established phenomenon.

American National Standards Institute (ANSI) B133.8 (1989 Gas Turbine Installation Sound Emissions) recommends limiting the noise emissions of new gas turbine facilities to 75 to 80 dBC at the nearest private residence in order to avoid any annoyance. C-weighting is used because it puts a greater emphasis on the lower end of the frequency spectrum and a range of values are given because the threshold is not sharply defined.

A generally equivalent criterion has been developed for use in the design of HVAC systems where thresholds for the perception of noise-induced vibration have been roughly determined in the lowest octave bands. Specifically, in the 31.5 Hz octave band, sound levels with magnitudes in the region between 65 and 75 dB are considered likely to cause moderately perceptible vibrations in lightweight frame structures and levels above 75 dB are associated with clearly perceptible vibrations. The same sound level would be less perceptible in a structure of more substantial construction.

In view of these criteria, a representative sampling of noise levels produced by typical combined cycle plants at fairly short distances is given below in Table 8.7-2.

Table 8.7-2. Noise levels produced by typical combined cycle plants at short distance.

	Octave Band Center Frequency, Hz										
Description	**31**	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	**dB(A)**	**dB(C)**
130-MW CC plant, 120 m from nearest HRSG	72	72	67	59	57	56	58	56	43	63	75
130 MW CC plant, 120 m from GT inlets	72	70	66	60	58	57	57	54	42	63	74
500-MW CC plant, 120 m from GT inlets	71	70	65	52	53	54	50	42	30	58	72
500-MW CC plant[1], 120 m from nearest HRSG	72	71	65	59	59	55	61	52	37	64	74
500-MW CC Plant, 150 m from nearest HRSG	71	70	62	60	59	57	53	48	46	62	73
Threshold of moderately perceptible noise-induced vibration	65	69									75
Threshold of clearly perceptible noise-induced vibration	75	79									80

[1]CC = combined cycle

Whether noise vibration from any given plant exceeds a particular threshold depends on the distance to the measurement location and the nature of the structure at that location. The nearest residence to the PPP is approximately one-half mile away from the facility, and therefore will not be affected. Commercial facilities much closer to the plant may see levels near this lower threshold for residential disturbance, but they are not expected to be adversely affected because of the heavier type of construction.

The City of Santa Clara noise ordinance (City of Santa Clara 1988) prohibits vibration perceptible by an individual at the closest property line point to the vibration source on the real property affected by the vibration. The perception threshold presented in the ordinance is a motion velocity of 0.01 inches/second over the frequency range of 1 to 100 Hz. The expected maximum vibration level at any point on the boundary is 0.004 inches second, which is 2.5 times less than the ordinance level. Thus, no vibration is expected to be detectable at the site boundaries or beyond the normal human senses.

8.7.2 Environmental Consequences

The power plant equipment and construction equipment will generate noise at known levels and the noise generated will dissipate at a predictable rate over distance. A computer model has been used to determine the expected noise levels at sensitive receptor locations around the site. These expected noise levels are then compared to the applicable regulatory standards and impact assessment criteria.

8.7.2.1 Significance Criteria

The project would cause a significant impact if it were to violate a local noise ordinance, regulation, or standard, or would increase the ambient noise levels by 5 dBA or more in a residential area that currently exceeds General Plan guidelines for residential area noise levels. For the PPP site, there are three sets of criteria that must be met. The first is the City of Santa Clara noise ordinance, which specifies a maximum property line level of 70 dBA for light industrial zones. This is not a weighted level such as the CNEL that is used in the noise compatibility table. It is the actual measured level that is not to be exceeded. The ordinance limit for residential areas at night is 50 dBA at the residential property line and the commercial limit is 60 dBA at night. Daytime limits are 5 dBA higher. The second set of criteria is the Noise and Land Use Compatibility Chart presented in Section 5.8 of Chapter 5 of the General Plan. This chart indicates that a CNEL level of 70 dBA is compatible for industrial zones. Since the CNEL measure weights evening noise levels by adding 5 dBA and nighttime noise levels by adding 10 dBA prior to computing the 24 hour average, the actual measured level required to achieve the specified CNEL level is lower by 6.7 dBA. This is equivalent to a measured level of 63.3 dBA at the boundary of an industrial noise source that operates 24-hours a day at a constant level of noise. The third criterion is from the CEC, which considers an increase in the late night L_{90} levels of greater than 5 dBA resulting from a power plant to be a significant impact. This criterion is based on CEQA guidelines. All of these criteria are presented in greater detail in Section 8.7.5 "Applicable Laws, Ordinances, Regulations and Standards".

8.7.2.2 Construction Phase Impacts

Noise will be produced at varying levels during the 18- to 21-month-long construction period, depending upon the construction phase. Construction of power plants and other industrial facilities can generally be divided into five phases, which involve different types of construction equipment and produce different amounts of noise. The phases are: 1) excavation, 2) concrete pouring, 3) steel erection, 4) mechanical, and 5) cleanup. One of the last activities, steam blowing, will be analyzed separately because of the potential for producing higher noise impacts. Construction of the natural gas pipeline was also analyzed.

Power Plant Site

Both the Environmental Protection Agency Office of Noise Abatement and Control and the Empire State Electric Energy Research Company have extensively studied noise from individual pieces of construction equipment as well as from construction sites of power plants and other types of facilities (EPA 1971; Barnes, Miller and Wood 1976). Since specific information on types, quantities, and operating schedules of construction equipment is not available for the project at this point in the project development, information from these documents for similar-sized industrial projects will be used. Use of this data, which is between 25 and 30 years old, is conservative since construction equipment now have more effective noise abatement.

The noisiest equipment types generally operating at a site during each phase of construction are presented in Table 8.7-3. The composite average or equivalent site noise level, representing noise from all equipment, is also presented in the table for each phase. Rock drills, at 98 dBA, produce the highest noise levels of any individual piece. The use of rock drills is very unlikely at the PPP site, however, due to the lack of bedrock in the construction zone. Heavy trucks operating at maximum engine speed are the second loudest equipment items, at 91 dBA.

Table 8.7-3. Construction equipment and composite site noise levels.

Construction Phase	Loudest Construction Equipment	Equipment Noise Level at 50 feet (dBA)	Composite Site Noise Level at 50 feet (dBA)
Site clearing and excavation	Dump Truck	91	89
	Backhoe	85	
Concrete pouring	Truck	91	78
	Concrete Mixer	85	
Well drilling	Diesel engine	85	Not Applicable
Steel erection	Derrick Crane	88	87
	Jack Hammer	88	
Mechanical	Derrick Crane	88	87
	Pneumatic Tools	86	
Clean-up	Rock Drill	98	89
	Truck	91	
High-pressure steam blow with silencer	Steam Blow	106	Not Applicable
Low-pressure steam blow	Steam Blow	80	Not Applicable

Source: USEPA 1971; Barnes, Miller and Wood 1976.

The steam blow, with an unsilenced level of 110 dBA at 1000 feet (or 136 dBA at 50 feet), is an activity rather than a piece of equipment. This activity is designed to clean scale and other debris from the boiler tubes and steam lines prior to admitting any steam to the steam turbines where the foreign material would damage the blades. A temporary bypass line to the atmosphere is welded into the main steam line upstream of the steam turbines to divert the steam. Several short blows of approximately two minutes duration each will be performed each day and the entire process generally takes several weeks. It has become relatively common in recent years to fit the steam blow pipe with a temporary silencer at sites near populated areas. These silencers have the capability to reduce levels by approximately 30 dBA. Such a silencer will be employed at the PPP site. In recent years, an alternative process using continuous blows of low-pressure steam over a 36-hour period has been developed that is inherently quieter. Noise levels are approximately 80 dBA at 50 feet from the discharge pipe. Use of this method may be employed in addition to or instead of the high-pressure, short-duration blow method.

Average or equivalent construction noise levels projected for three sensitive receptor monitoring sites are presented in Table 8.7-4.

These results are conservative because the only attenuating mechanism considered was divergence of the sound waves over the distances traveled. In actuality, the large buildings that surround the PPP site will substantially block much of the sound. Levels during the loudest normal construction activities are projected to be between 43 dBA and 58 dBA at the sensitive receptor locations at distances ranging from 0.34 miles to 0.51 miles. These levels are approximately equal to the existing daytime L_{90} levels. Thus, average construction noise generally will not present a significant noise impact. Levels of 71 to 75 dBA during muffled steam blowing will be similar to levels created by existing traffic and jet aircraft and will not create a significant noise impact during the day. High-pressure steam blowing will be restricted to the daylight hours if necessary to avoid nighttime impacts. If the lower pressure continuous blow method is selected for cleaning the steam pipes, noise levels at the sensitive receptors would range from 45 to 49 dBA and would not represent a significant noise impact, even at night.

Table 8.7-4. Average expected construction noise levels at sensitive receptor locations[1].

Construction Phase	Location 1 Nearest residences on Lafayette Street 0.51 miles	Location 3 Granada Islamic School 0.42 miles	Location 4 Apartments on Laurelwood Road 0.34 miles
Excavation	54	56	58
Concrete Pouring	43	45	47
Steel Erection	52	54	56
Mechanical	52	54	56
Clean-up	54	56	58
HP Steam blow with silencer[2]	71	73	75
LP Steam Blow without silencer (36-hr duration)	45	47	49

[1]Location 2 is on the site and is not a sensitive location.
[2]High Pressure Steam blow levels are instantaneous rather than averaged.

Construction Vibration

The only construction activity likely to have a potential to create significant vibration is pile driving. Impact pile driving can produce perceptible vibrations typically within a few hundred-foot radius of the activity. Since no pile driving is anticipated at the PPP site, no perceptible vibration is anticipated at any off-site location.

Natural Gas Pipeline

Natural gas pipeline construction equipment will include concrete saws, backhoes, trenchers, pipe layers, dump trucks, pavers, compactors, and other miscellaneous equipment. All of this equipment produces noise levels between approximately 80 dBA and 91 dBA at 50 feet. Workers operating the equipment and other workers within approximately 50 feet of the equipment will wear hearing protection. Persons outside the work area should never be exposed to levels above approximately 85 dBA. This activity may be conducted at night to minimize disruption to daytime traffic on Lafayette Street, but it should only be conducted during the day when adjacent to residential areas. Daytime noise levels near residential areas could increase to approximately 70 dBA, which is similar to existing daytime Leq and L_{10} noise levels. Since this activity is short-duration at any given location, and will only occur during the day in noise-sensitive areas, any noise impact created will not be significant.

Waste Water Discharge Pipeline

Construction equipment for installing the waste water discharge pipeline will be the same as for the natural gas pipeline.

8.7.2.3 Operational Phase Impacts

Operational noise will result from the operation of the power plant equipment including the gas and steam turbines, cooling tower, and HRSGs. A noise modeling program, Cadna/A, ver. 3.0, developed by the

German firm DataKustik specifically for power plant applications, was used to evaluate the noise emissions of the facility. Based on the sound power levels input for each source, the program maps the noise contours of the overall plant in accordance with a variety of European standards, primarily VDI 2714 *Outdoor Sound Propagation* and ISO 9613. All sound propagation losses such as geometric spreading, air absorption, ground absorption, and barrier blockage are calculated automatically in accordance with these recognized standards. Internal shielding within the plant, such as by the large HRSG structures, is realistically accounted for in the model because the physical dimensions of each source are also input to the program and considered in the calculations. Shielding beyond the plant by the numerous intervening warehouse and commercial structures in the direction of the three sensitive receptors has been accounted for very conservatively—to the extent that the predicted levels at these receptors are virtually unaffected. Only the closest off-site buildings were treated in the model as barriers to noise.

Sound power levels of equipment used as input to the noise model were obtained from the equipment manufacturers, first hand measurements of similar equipment, or from the literature. The plant was first modeled assuming that all of the equipment was standard or typical in terms of the amount of noise control features included. For example, all combustion turbines supplied for power plants are enclosed in standard outdoor acoustical enclosures and fitted with combustion air inlet silencers. These features were included in the first model run. Other noise control features were then included, as required, to ensure that the plant will meet all of the applicable criteria.

Noise Modeling Summary

Noise modeling results for the Pico Plant in relation to relevant noise standards are summarized in Table 8.7-5. Noise modeling parameters are found in Appendix 8.7-A. These results indicate that noise produced by a standard plant will be at or below the City of Santa Clara Noise Ordinance levels and the City's General Plan Land Use Compatibility levels at the three noise-sensitive receptors (locations 1, 3, and 4). At these same three locations, the expected plant noise levels are also below the existing nighttime L_{90} levels by 6 to 10 dBA. Thus, the expected levels are in compliance with applicable LORS and do not exceed the CEC criterion of less than a 5 dBA increase in background noise levels at the nearest noise-sensitive areas with a standard plant, and will not require additional mitigation.

However, at Location 2 on the north site boundary, the expected levels for a standard plant exceed the ordinance and General Plan levels by up to 15 dBA. Although not applicable for industrial locations, the expected levels also exceed the existing nighttime background levels by up to approximately 23 dBA. The primary reason for this exceedance is not that the plant is unusually loud, but rather that the equipment is relatively near the site boundary. The small size of the site does not allow much flexibility in arranging equipment to avoid this situation. Consequently, mitigation measures have been incorporated into the design of the plant to permit noise levels to meet the criteria. The mitigation measures affect only those sources of noise that are close to the ground and, thus, have little impact on expected levels at the more distant sensitive-receptors. Although levels will be reduced by up to 18 dBA at the site boundary, these distant receptor noise levels will only be reduced by approximately 0.3 dBA.

Table 8.7-5. Summary of noise modeling results.

Receptor Position	City of Santa Clara Noise Ordinance (Leq not to exceed at night) (dBA)	City of Santa Clara General Plan, Noise Compatibility (CNEL) (dBA)	Average measured background Level, L_{90} (10 p.m. - 7 a.m.) (dBA)	Expected baseline plant noise level (dBA)	Difference between existing and expected (dBA)
Location 1: Residences on Lafayette Street	50	55 (Leq = 48.3)	47.6	41.3	-6.3
Location 2: North site boundary	70	70 (Leq = 63.3)	55.1	78 wo/mitigation 60 w/mitigation	+22.9 +4.9
Location 3: Granada Islamic School	50	55 (Leq = 48.3)	52.6	42.5	-10.1
Location 4: Apartments on Laurelwood Road	50	55 (Leq = 48.3)	55.3	45.3	-10.0

The mitigation measures used to meet the City's noise standards may include:

1. 15-foot-tall barrier wall on the west boundary
2. 25-foot-tall barrier wall on the north boundary
3. 20-foot-tall barrier wall on the northeast boundary
4. 23-foot-tall barrier wall on the east and south sides of the steam turbine generator
5. 10-foot-tall barrier wall on the north, east and south sides of the circulating water pumps
6. Splash baffles in the cooling tower water basin
7. Generally closed louvers, especially at night, on the east side dry inlet of the cooling tower
8. Both ends of the cooling tower completely closed
9. Gas compressors enclosed in a building

Figure 8.7-8 presents a noise contour map of the site and natural gas compressor station with these noise barrier walls. These noise contours indicate that expected noise levels immediately outside the site boundary and beyond will be below 63.3 dBA (equivalent to the General Plan Land Use Compatibility Level of a CNEL of 70 dBA for industrially zoned property) at all locations around the site. Thus, with these measures, the project will also be in compliance with the City of Santa Clara requirements for industrial property. As the figure indicates, the noise contours immediately adjacent to the gas compressor building are at 60 dBA and thus meet the City's noise standards at the property line.

Some attention will also be given to start-up and other transient noise. Vent silencers with reasonable performance will be needed to prevent any impact at the nearest residences. In conclusion, after implementation of mitigation measures, no significant noise impacts are expected to result at any noise-sensitive receptor around the plant because of the large distances between the plant and the sensitive receptors. The highest level predicted at any residence is approximately 45 dBA. Significant noise control or mitigation measures are proposed to meet the industrial boundary limits of the City of Santa Clara. These measures have been incorporated into the current design. It is possible that some of these measures will ultimately be replaced during final design with other measures that will achieve the same result but in a different manner. For example, use of quieter equipment could eliminate the need for some of the walls, or at least lower the current expected heights of walls.

Vibration Impacts

As discussed in Section 8.7.1.3, the air and ground vibration levels that will be produced by the PPP will be less than those that presently exist in the local urban environment (e.g., truck traffic). The expected level at the nearest point on the site boundary, with the equipment operating at the maximum allowable level, will be at the threshold of perception and 25 times less than the City of Santa Clara allows. At all greater distances beyond the boundary, the level will be below the threshold of perception.

8.7.3 Cumulative Impacts

Increases in noise levels above existing ambient levels during construction and operation will generally not be noticeable beyond one mile from the site. Thus, direct cumulative impacts with other projects will only occur if the other new projects are located within a one-mile radius of the site. No similar projects are known to be planned in the area, and so no direct cumulative noise impacts will occur.

Very small increases in highway traffic noise will occur throughout a large area extending beyond the one-mile radius described above during construction and operation of the project. Increased traffic noise will exist from the origination point of each individual trip to the Pico site as well as on the return trip. Some overlap with traffic due to other new and planned projects will undoubtedly occur at distant locations. However, due to the logarithmic nature of decibel addition, significant changes in the volume of traffic are required to effect even minor changes in noise levels. For example, a doubling of the volume of traffic is required to increase the traffic noise level by the barely noticeable amount of 3 dBA. The cumulative increase in traffic volumes will not be doubled at any location, near or far. Thus, there will be no noticeable indirect cumulative noise impact due to highway traffic.

8.7.4 Mitigation Measures

The noise control measures that will be installed in the plant to mitigate noise impacts are discussed above.

A complaint resolution procedure presented in the following paragraphs will provide an efficient and effective means of receiving and resolving any noise complaints. An outline sample form for the procedure is provided in Appendix 8.7-B.

Any noise complaints received by the facility will be entered in a "Noise Complaint Logbook". The date, time, name, address and phone number of complainant, nature of the complaint and name of the person receiving the call will be recorded. The logbook entries will always be chronological in order and simply provide evidence that a complaint was received. The caller will then be transferred to the plant manager or shift supervisor who will obtain a thorough understanding of the complaint so that appropriate action can be taken. The manager will briefly explain the resolution procedure to the caller

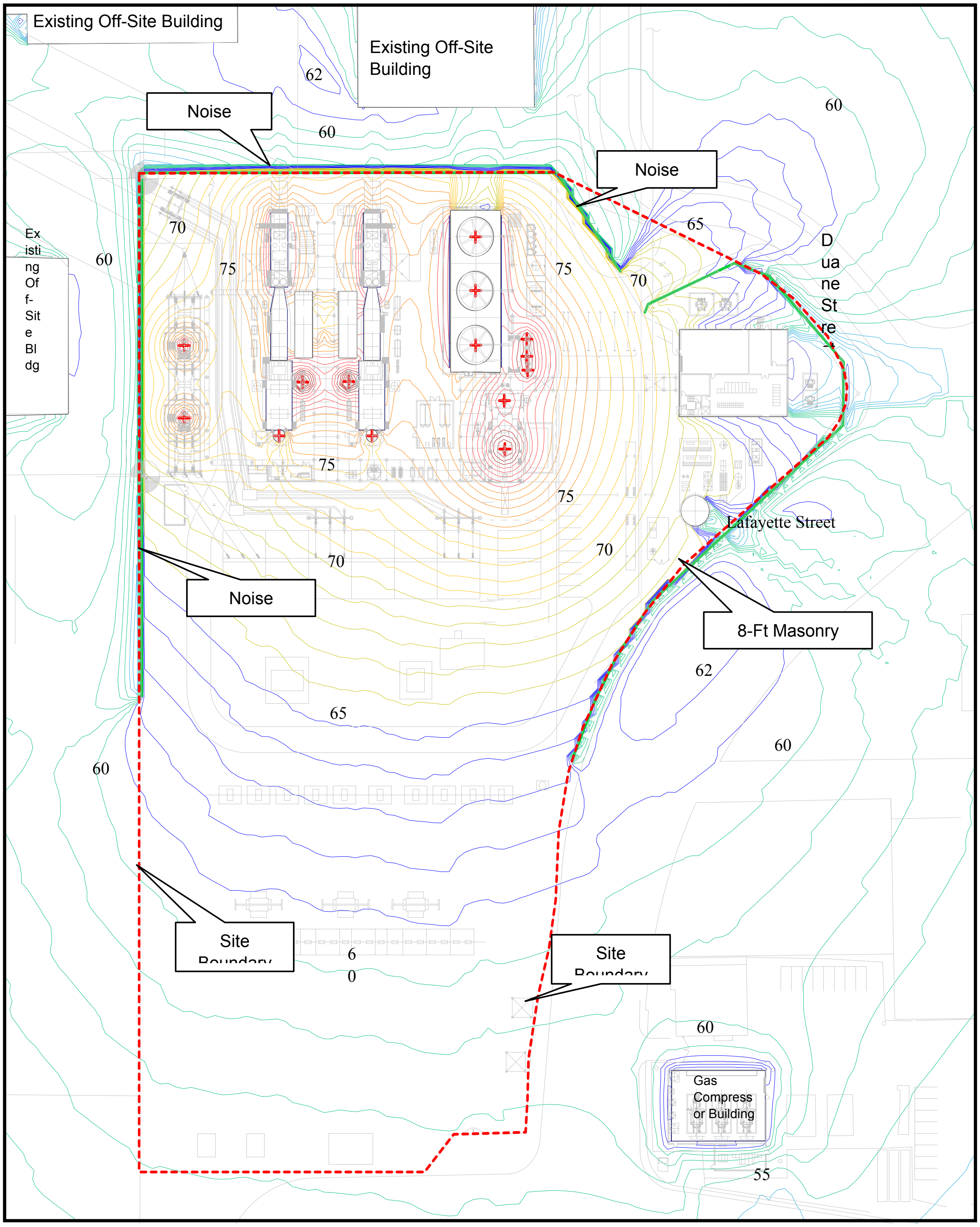


Figure 8.7-8. Expected plant noise emissions (A-weighted sound level contours).

and provide assurance that the problem will be investigated in a timely manner and corrected to the fullest extent practicable.

The manager will then record the information from the logbook on a blank "Noise Complaint Resolution" form presented below. This form provides additional space for a description of the problem and measures taken to resolve the problem. These loose-leaf-preprinted forms will be kept in a three-ring binder maintained by the plant manager or a designee.

In a situation where the complaint does not appear to be justified, as based on measured levels or other criteria, or where the plant manager believes the problem to be corrected but the complainant is not satisfied, additional recourse measures will be provided to the complainant. These will include the name and phone number of the City of Santa Clara noise code enforcement official responsible for ensuring compliance with conditions of certification of the project. The Noise Complaint Logbook, the loose-leaf book of noise forms, copies of letters sent to complainants, and any other material documenting changes in procedure or installation of noise control materials will be made available to the appropriate officials, as requested.

8.7.5 Applicable Laws, Ordinances, Regulations, and Standards

The controlling criterion in the design of the noise control features for the project is the minimum, or most stringent, noise level required by any of the applicable LORS. Since the site is in the City of Santa Clara, it must satisfy the City regulations; and because the CEC will license the facility, it must also comply with CEC requirements. The CEC defines the area impacted by the proposed project as that area where there is a potential increase in existing noise levels of 5 dBA or more during construction or operation.

The following are the LORS that apply to noise generated by the PPP. These LORS are also summarized in Table 8.7-6.

8.7.5.1 Federal

The federal government has no standards or regulations applicable to off-site noise levels from the project. However, guidelines are available from the USEPA (1974) to assist state and local government entities in development of state and local LORS for noise.

On-site noise levels are regulated, in a sense, through the Occupational Safety and Health Act of 1970 and through the Occupational Safety and Health Administration (OSHA). The noise exposure level of workers is regulated at 90 dBA over an 8-hour work shift to protect hearing (29 Code of Federal Regulations [CFR] 1910.95). On-site noise levels will generally be in the 70 to 85 dBA range. Areas above 85 dBA will be posted as high noise level areas and hearing protection will be required. The power plant will implement a hearing conservation program for applicable employees and maintain exposure levels below 90 dBA.

8.7.5.2 State

Two state laws address occupational noise exposure and vehicle noise and apply to the PPP. The California Department of Industrial Regions, Division of Occupational Safety and Health, enforces California Occupation Safety and Health Administration (Cal-OSHA) regulations, which are the same as the federal OSHA regulations described above. The regulations are contained in 8 California Code of Regulations (CCR), General Industrial Safety Orders, Article 105, Control of Noise Exposure, Sections 5095, et seq. Noise limits for highway vehicles are regulated under the California Vehicle Code, Sections

23130 and 23130.5. The limits are enforceable on the highways by the California Highway Patrol, the Santa Clara County Sheriff's Office, and the City of Santa Clara Police Department.

Table 8.7-6. LORS applicable to noise.

Law, Ordinance, Regulation, or Standard	Applicability	Mitigation Effective?	AFC Reference
Federal Offsite: USEPA	Guidelines for state and local governments	Not applicable	Not applicable
Federal Onsite: OSHA	Exposure of workers over 8-hour shift limited to 90 dBA	Yes	Section 8.7.6.1. See also Worker Safety section of AFC.
State Onsite: Cal-OSHA 8 CCR Article 105, Sections 5095 et seq.	Exposure of workers over 8-hour shift limited to 90 dBA	Yes	Section 8.7.6.2. See also Worker Safety section of AFC.
State Offsite: California Vehicle Code, Sections 23130 and 23130.5	Regulates vehicle noise limits on California highways.	Yes	Delivery trucks and other vehicles will meet Code requirements.
Local: California Government Code, Section 65302	Requires local government to prepare plans that contain noise provisions.	Yes	City of Santa Clara conforms.
City of Santa Clara General Plan Noise and Land Use Compatibility Guidelines	Limits noise to 55 dBA CNEL at residences, 65 dBA CNEL at commercial and 70 dBA CNEL at industrial locations.	Yes	Section 8.7.6.3.
City of Santa Clara Noise Ordinance	Limits noise to 55 dBA at residences, 65 dBA at commercial and 70 dBA at industrial locations. Nighttime limits are 5 dBA lower at residences and commercial areas.	Yes	Section 8.7.6.3.

8.7.5.3 Local

The California State Planning Law (California Government Code Section 65302) requires that all cities, counties, and entities such as multi-city port authorities prepare and adopt a General Plan to guide community change. The City of Santa Clara General Plan contains the "Noise and Land Use Compatibility" chart that details the noise levels applicable to different types of land use. Compatible Community Noise Equivalent Levels (CNEL) are 55 dBA for residences and schools, 65 dBA for recreational areas and commercial uses, and 70 dBA for industrial areas (City of Santa Clara 1992). Levels of continuous noise that are equivalent to these CNEL levels are 6.7 dBA below the levels presented above. Thus, if a power plant produced a constant noise level of 63.3 dBA at a location, the CNEL, after application of the evening and nighttime penalties of 5 and 10 dBA, respectively, would be 70 dBA.

The City of Santa Clara also has a Noise Ordinance that carries more legal weight than the General Plan guidelines above (City of Santa Clara 1988). These enforceable limits are higher at 50 dBA, 60 dBA and 70 dBA at night for residential, commercial and light industrial areas, respectively. Daytime limits are 5 dBA higher for residential and commercial areas. Since these levels are higher than the General Plan guidelines, compliance with these is guaranteed if the General Plan limits are met. The plant has been designed to meet the lower limits in the General Plan.

8.7.6 Involved Agencies and Agency Contacts

The agency responsible for enforcement of noise levels at the PPP is the City of Santa Clara Planning Department. The person to contact regarding noise emission levels from the plant is shown in Table 8.7-7.

Table 8.7-7. Involved agencies and agency contacts.

Permits/Reason for Involvement	Contact	Title	Telephone
Information regarding City Noise Policy.	Kevin Riley City of Santa Clara Planning Department	Principal Planner	(408) 615-2450

8.7.7 Permits Required and Permit Schedule

No noise permits are required.

8.7.8 References Cited

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